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(71) Applicant:
LOPTIQUE Gesellschaft für Lichtsysteme mbH, DE

(74) Representative:
Schulte, J., Dipl.-Ing., Pat.-Anw., 45219 Essen

(72) Inventor:
Blessing, Kurt, 45481 Mühlheim, DE

(54) Low-Power-Consumption Lighting Unit

(57) A lighting unit for the uniform illumination of areas and rooms includes an electronic module 3 comprising at least three semiconductor elements or luminescent diodes 4, 5, 6, each of which generates a luminous intensity of at least 0.2 cd, and each of which emits light in at least three different wavelength ranges. The module 3 is equipped with an electronic circuit and power supply 14 through which the individual luminescent diodes 4, 5, 6 can be controlled simultaneously. Lighting units 1 of this type exhibit an extremely long service life and low power consumption. In addition, they are characterized by small size while providing a high light intensity.

[Diagram]

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Description

The invention relates to a lighting unit with an artificial light source for the uniform illumination of areas and rooms, the lighting unit being created from a plurality of semiconductor elements forming a module which emits light in different wavelength regions.

Ordinarily, incandescent or halogen lamps, fluorescent lamps, and other discharge lamps are employed to illuminate homes, offices, medical treatment facilities and sales facilities,.as well as sports arenas and other outdoor facilities. The above-mentioned illumination means or light sources are also utilized in the area of photo optics or stage technology to fully illuminate or to floodlight persons, areas, or objects. General requirements, such as uniformity of illumination, miniaturization of the lighting units themselves, proper color rendition, glare restriction, as well as variability in the light emission angle, together with high luminous efficiency, have resulted in the fact that low-voltage halogen lamps or fluorescent lamps have been the principal types used. These illumination means or light sources have generally been augmented by using reflectors or reflector systems to fulfill the desired illumination requirement. A common feature of all conventional lighting units is the fact that their illumination means are mounted in holders, or that the holders are used to supply the requisite current which is provided by ballasts such as appropriate chokes or transformers. One disadvantageous aspect of this prior art is that the service life of the light sources is relatively low, amounting at best to 8,000 operational hours in the case of fluorescent lamps. The result is that the operating costs for these lighting units are high, specifically in terms of high costs for replacement components, as well as high service costs for the labor needed, for example, to replace the light source itself. At least as disadvantageous is the poor efficiency of the above-mentioned light sources due to the fact that a large fraction of the electrical energy, rather than being converted into visible light, is instead converted into convective heat as well as invisible infrared or ultraviolet radiation which additionally may be injurious to health. Additional disadvantages of conventional lighting units relate to the size of the lighting units which is fundamentally affected by the requisite reflector which is relatively large and may not be utilized to modify the color of the emitted light.

Another known technology employs luminescent diodes. Generally, these involve semiconductor diodes which emit electromagnetic radiation when the flow of current is in the forward direction. The wavelength of the emitted radiation is fundamentally determined by the semiconductor material used and is restricted to a narrow wavelength range based on the electronic junctions which produce the emission. Known luminescent diodes include LEDs with two, three, or four semiconductor elements which emit light of different colors depending on the type of connector pins which are activated, these pins being connected to the respective different semiconductor elements within the LED. In order to signal measurement data, one or the other color is generated individually as a function of the switching state. The use of LEDs in the prior art is essentially limited to signal elements, photoelectric barriers, punch card readers, IR remote control equipment, and photo detectors. Light-emitting semiconductor elements are also employed for the backlighting of displays. Due to their available luminous efficiency, LEDs are also currently used in automobiles as position lights, brake lights, and turn-signal lights (DE-A1-42 28 895). When used in vehicle headlights, the principle is that each semiconductor light source emits only light of

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one color such that a light of uniform color emerges as a result of the superimposition of the light emitted by all of the semiconductor light sources. The patent DE-A1-38 27 083 similarly describes high-luminous-intensity semiconductor elements which generate red light at an emission angle of 1-3 cd. The disadvantageous aspect of all of these uses for semiconductor elements as light sources is that none of them enable high-performance lighting units to be made and that the required white light is difficult to obtain.

The goal of the invention is therefore to create a lighting unit which is of small dimensional size but which nevertheless has a high degree of efficiency and a long service life.

This goal is achieved according to the invention by providing an electronic module which is in the form of an integrated chip/circuit which accommodates the individual light-emitting semiconductor elements, by the fact that the luminescent diodes have a luminous intensity of 0.2 cd, and by the fact that the light emission angle of the luminescent diodes is large enough that at a short distance essentially white light is produced on the object being illuminated.

Modules of this type may be fabricated, for example, using SMD technology, the individual semiconductor elements being integrated into the chip or circuit. This chip may, for example, have conventional plug-in connectors, the uniform illumination being provided by the use of appropriate semiconductor elements which generate a luminous intensity of at least 0.2 cd and emit light in at least three different wavelength regions. The use of additive superimposition of the wavelength regions and of the appropriate light emission angle for the luminescent diodes or semiconductor elements ensures that essentially white light illuminates the object to be illuminated. The use of appropriate luminescent diodes, together with their arrangement and integration in the circuit, enable the desired cost-effective lighting units of small size and high efficiency to be realized.

In one advantageous embodiment of the invention, the circuit is equipped with a power supply integrated into the light source and a control unit for the luminescent diodes, each of which is designed preferably to generate a luminous intensity of 1 cd. Since it is possible, according to the invention, to employ different semiconductor elements with different minimum voltages as a function of the specific module, it is of considerable advantage to have a power supply with the appropriate voltage matched to the specific semiconductor element. Preferably, the specific power supply may also be a regulating circuit for the supply voltage along the lines of a potentiometer which controls the brightness of the specific semiconductor element. According to the invention, semiconductor elements are employed which simultaneously generate the three primary colors red, green, and blue. The complex arrangement and control system for the different semiconductor elements thus become unnecessary. In the case of luminescent diodes of 1 cd, the number of luminescent diodes or semiconductors used may be advantageously reduced, thereby allowing the lighting units to be of an even smaller design.

In another advantageous embodiment, the light source has a sealed casing with a plastic body and/or glass body and is connectable through the base or holder to the ac power grid. Here the semiconductor elements are directly integrated into a chip, thereby not only reducing the overall size but also preventing any health hazard since no UV radiation or IR radiation is emitted. Since the light source according to the invention produces a high luminous efficiency at low temperatures, it is easily possible to integrate it into a sealed plastic or glass casing so that it is possible to use the usual connection means

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through the socket or base known from conventional light sources. The great advantage of this is that light sources or lighting units in general of this type are readily accepted by the market.

In order to make light sources of this type as complete lighting sources, the invention provides that the power supply and control unit for the luminescent diodes are integrated into the sealed casing of the light source. Based on the appropriate connectors of conventional design for connection to the ac power grid, it is possible to use light sources of this type practically anywhere.

The versatility of the invention is also evidenced by the fact that in one embodiment the casing is composed of a combustible material such as cardboard, fabric, or plastic. As a result, due to the advantageous design and low temperatures which are applied to the semiconductor elements or luminescent diodes, as well as at the power supply, it is possible for the first time to directly combine these materials that are critical to the optics with the casing itself, that is, with the light source. Completely new effects and types of applications thus become possible without the risk that these would result in any hazards. The efficiency of the individual light source, and thus of the lighting unit, is enhanced in a targeted manner according to the invention by making the chip is reflective on the side with the semiconductor elements.

It was mentioned above that the power supply and control unit for the luminescent diodes are integrated into the sealed casing of the light source. This involves an implementation that is optimally adapted to the size parameters in which the power supply and transformation are provided by ac/dc and dc/ac converters. Components of this type may also be advantageously integrated into the chip, or into the casing of the light source, such that they are in a protected arrangement, while remaining fully effective and also providing the possibility that these light sources or lighting units be connected to conventional ac power supplies.

In an advantageous embodiment of the lighting unit according to the invention, an optical component is added to the luminescent diodes, which component homogenizes the color of the light and distributes the luminous intensity. The component is advantageously a lens or diffuser, and it is possible to employ lenses of any design. The concentration of the different light waves achieves a targeted modification of the type already described.

Due to the extremely low power consumption of the circuit or of the individual luminescent diodes, the invention is particularly well suited for use in connection with solar energy. The circuit or power supply, according to the invention, is thus designed to be connected to solar cells. It is thus possible to use solar cells and photovoltaic components on a larger scale for outdoor lighting fixtures or interior lighting fixtures which are used in combination with the exploitation of daylight. In this case, the daylight is converted into electric current which charges secondary cells and, in response to a triggering pulse, releases the stored energy to supply electric power to the semiconductor elements. Since this process occurs only with direct current, there is the advantage of no transformation loss. It is advantageous here if the circuit or casing has a photo-electric lighting controller or timer switch since these are able to ensure that the power consumption is initiated only when necessary based on the lighting conditions. This feature also ensures that the power supply does not fail too soon due to a low storage level in the batteries.

The invention is distinguished in particular by the fact that use of the light source or lighting unit according to the invention provides a uniform illumination since each of the semiconductor elements, which generates a luminous intensity of 0.2 cd and emits light in at least three different

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wavelength regions, is individually controlled simultaneously with the others by an electric switch, and by the fact that through the additive superimposition of the wavelength regions essentially white light is emitted onto the object being illuminated. The fact that the luminescent diodes have a service life of 100,000 hours with only a 25% drop in performance provides the particular advantage that the need to replace the luminescent diodes is almost completely eliminated. Since the luminescent diodes additionally are of extremely small size, it is also possible to produce an extremely small size for a complete lighting unit which also has a high luminous intensity. UV and IR radiation are avoided and as a result, no health hazard can occur. The low-profile design and low temperatures applied to the semiconductor elements and to the power supply permit the use of easily combustible materials even as the casing material. These features open up many new application and design opportunities. At least three semiconductor elements are used; but preferably in order to achieve the most uniform luminous color possible on the illuminated object, at least nine and specifically 27 are preferably used for this purpose. It is also possible to link multiple smaller element modules together to create one large module. The number of semiconductor elements is limited only by the size of the elements and the maximum size of the lighting unit. The light emission angle of the semiconductor elements radiating in the various colors is sufficiently large, and the elements are appropriately arranged in such a way, that the light of the various wavelength regions is superimposed so that essentially white light is produced. It is also possible to impart a coloration to the white light by appropriately adjusting the supply voltages applied to the respective semiconductor elements, or through selection of the semiconductor elements themselves, if reasons relating to the illumination technology make this desirable. An additional advantage is the fact that the lighting unit according to the invention may be coupled with the use of solar energy, especially as this feature enables transformation losses to be avoided, thereby providing better efficiency in terms of the available energy used. The integration of all the components including the circuit, the power supply, and the control unit within one complete sealed casing additionally offers the advantageous possibility of providing light sources of this type with commercially available sockets or bases, thereby making their use significantly more convenient. Finally, the use of secondary cells or batteries allows portable units to be made.

Additional details and advantages of the invention will be shown in the following description based on the attached drawing which illustrates a preferred embodiment together with the requisite details and individual components.

Figure 1a is a perspective view of a plurality of luminescent diodes on a circuit board;

Figure 1b is a top view of a plurality of luminescent diodes on a circuit board;

Figure 2 is a schematic view of a pluraliity of luminescent diodes on a circuit board together with a converging lens as the optical component;

Figure 3 shows a chip on which 25 semiconductor elements have been integrated;

Figure 4 shows a sealed casing in which the chip with its semiconductor elements plus the power supply with its control unit have been installed; and

Figure 5 shows another casing, into which a circuit board with luminescent diodes, and a power supply and control unit have been integrated.

Figure 1a illustrates a simple design for a lighting unit 1 or a light source 2, here composed simply of a circuit board 10

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including a module 3 with various semiconductors 4 or luminescent diodes 5, 6. Luminescent diodes 4, 5 6, are driven here by a separate power supply, not shown here.

Figure 1b is a top view of circuit board 10 with a pluraliity of luminescent diodes 4, 5, 6, which are arranged here symmetrically.

Figure 2 shows a circuit board 10, in front of which an optical component 16 is located which superimposes and mixes the individual beam paths 18, 19, 20 and color components within a focus 17.

Figure 3 shows a chip or circuit 8 which is populated with semiconductor elements or luminescent diodes 4, 5, 6 and which, in terms of its design, is well suited to being installed in a variety of light sources 2 or lighting units 1.

Figures 4 and 5 illustrate how the requisite components, such as the chip or circuit 8, or circuit board 10 plus luminescent diodes 4, 5, 6, can be combined with a sealed casing 9. According to Figure 4, this sealed casing 9 has approximately the shape of an incandescent bulb, the integrated circuit 8 being evident in the interior of casing 9. Power supply 14 and the control unit, not shown here, are also integrated into this unit. The lower section 22 of casing 9 forms a closed unit and may even be coated with combustible materials such as cardboard, fabric, or plastics since the temperatures produced within casing 9 are insignificant.

Molded on to component 22 of casing 9 is a socket 11 which allows the unit to be screwed into a corresponding base of, for example, a lamp or lighting unit 1 which is able to utilize existing technology. As a result, direction connection to an ac power supply is possible, whereby the power supply and control of luminescent diodes 4, 5, 6 are enabled through power supply 14 and the control unit.

As shown in Figure 5, casing 9 may also have a different shape. Here casing 9 is equipped with a socket 12 including plug components 13, with the result that here again it is possible to employ the unit in, for example, halogen lamps, with which it is then possible to use a simplified power supply 14 since transformers are generally already present in lighting unit 1. Casing 9 is sealed, in a manner analogous to the implementation of Figure 4, by a protective glass 21 so as to create a protected interior space 23. To increase light intensity, it is possible to reflectively coat the side 15 of circuit board 10 or of chip 8 holding luminescent diodes 4, 5, 6.

All features referenced above, including those found only in the drawings, are considered essential to the invention, whether singly or in combination.

Claims

1. Lighting unit (1) with an artificial light source (2) for uniform illumination of areas and rooms, the lighting unit being created from a pluraliity of semiconductor elements (4) forming a module (3) which emits light in different wavelength regions, **characterized in** that the electronic module (3) is in the form of a chip/circuit (8), that the semiconductor elements (4, 5, 6) have a luminous intensity of 0.2 cd, and that the light emission angle of the semiconductor elements (4, 5, 6) is large enough that at a short distance essentially white light is produced on the object being illuminated.

2. Lighting unit according to Claim 1, characterized in that the circuit (8) is equipped with a power supply (14) integrated into the light source (2), and with a control unit for the semiconductor elements (4, 5, 6), which are each preferably designed to generate a luminous intensity of 1 cd.

3. Lighting unit according to one of the foregoing claims, characterized in that the light source (2) has a sealed casing (9) with a plastic and/or glass body, and the light source

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can be connected through the socket (11) or base (12) to an ac power grid.

4. Lighting unit according to Claim 2 or Claim 3, characterized in that the power supply (14) and control unit for the semiconductor elements (4, 5, 6) are integrated into the sealed casing (9) of the light source (2).

5. Lighting unit according to one of the foregoing claims, characterized in that the casing (9) is composed of a combustible material such as cardboard, textile fabric, or plastic.

6. Lighting unit according to one of the foregoing claims, characterized in that the chip (8) is reflective on the side (15) with the semiconductor elements (4, 5, 6).

7. Lighting unit according to one of the foregoing claims, characterized in that the power supply (14) and transformation are provided by ac/dc and dc/ac converters.

8. Lighting unit according to one of the foregoing claims, characterized in that an optical component (16) is added to the luminescent diodes (4, 5, 6) to homogenize the color of the light and to distribute the luminous intensity.

9. Lighting unit according to Claim 8, characterized in that the optical component (16) is a lens or diffuser.

10. Lighting unit according to one of the foregoing claims, characterized in that the circuit (8) or power supply (14) can be connected to solar cells.

11. Lighting unit according to one of the foregoing claims, characterized in that a secondary cell or battery is added to the casing (9) accommodating the circuit (8) or accommodating circuit (8), power supply (14), and control unit for the semiconductor elements (4, 5, 6).

12. Lighting unit according to Claim 11, characterized in that the circuit (8) or casing (9) has a photo-electric lighting controller or timer switch.

Two pages of drawings follow.

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